GLOBAL CHALLENGES AND BIOFUELS

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Abstract

With the current phenomena of increasing food and oil prices there is an urgent need to scrutinize the controversial role of biofuels. They have recently been considered as both the promising source of inexpensive and sustainable energy and the underlying reason for soaring agricultural commodity prices. Owing to gradually growing population, that is forecast to reach 9 billion by 2050, and developing countries having higher standard of living, the society is faced with a great challenge of increased demand for food and energy never seen before. This, combined with declining oil reserves and substantial greenhouse gas emissions, has made groups of scientist, policy-makers as well as companies turn to the use of biofuels. The purpose of this paper is to conduct an analysis on the economic and environmental impact of large scale biofuels production with respect to food price spikes, energy-efficiency and carbon-debt issues.

Key Words: *biofuels, energy supply, food security, climate change*

JEL Classification: Q16

1. INTRODUCTION

It has become generally accepted that climate change is mainly caused by anthropogenic (human-caused) emissions of greenhouse gases, of which significant part stems form the use of fossil fuels. According to the World Resource Institute (2011), among the major polluters in terms of GHGs were China, the US and the EU-27 in 2007 with their share of world total being 22.7%, 19.73% and 13.76% respectively. Looking at the cumulative emissions of period 1850-2007 the same countries are found on top of the list, however, the emission of the US and the EU-27 is three times more than that of China.

Another major problem mankind is faced with is food security. The latest estimate of the most frequently cited statistic on the number of malnourished people, the Food and Agriculture Organization (FAO, 2011), there are 925 million undernourished around the world. This makes up 13.6 percent of the estimated world population of 6.8 billion. World Hunger stresses that the principal cause of famine is the lack of sufficient land to grow, income to purchase. Rising food prices, the world saw global food prices reaching record highs in 2008, exacerbates the problem further.

Climate change and the globally worsening weather conditions accompanying it in the recent years have drawn a lot of attention. A greater emphasis has been put on regulations and on turning to alternative energy sources at a faster rate to achieve sustainable development. One alternative to fossil fuels is biofuels. However, some have doubts regarding their use to replace fossil fuels in transportation, claiming they are responsible to a great extent for the price increase the agricultural commodity market saw. For instance, the World Bank (2008) and the IMF (2008) argue that 70-75 percent of the food price increase in 2008 can be attributed to biofuel expansion. Similarly, Lipsky (2008) reckons that 70 percent of corn and 40 percent of soybean price rise was related to increased biofuel production.

This paper aims to investigate the interdependency between energy, bioenergy (biodiesel) and agricultural markets. It focuses on the world's biggest economy, the United States and examines how biodiesel production has had an impact on soybean oil prices in the period of 2001-2011.

2. METHODOLOGY

In the field of biofuels and their relationship with fossil fuels and agricultural commodities there are great number of articles published, which provided insights

with regard to scoping this study and gaining a better understanding of the issue. They also played an important role in helping to find the tools for approaching the method. Data related to demand, supply and prices of the components of the study (fossil fuels, biofuel, farm crop) come, among other, from the International Monetary Fund (IMF), Alternative Fuels and Advanced Vehicles Data Center (AFDC) and the U.S. Department of Agriculture (USDA), and cover the period 2001-2011.

The article appraises the relationship among the following: fuel prices (gasoline, diesel, biodiesel) and selected agricultural commodity prices (soybean and soybean oil). Results are received through correlation and regression analysis. As it takes time for agricultural prices to adapt to the price changes of their drivers, a lag of a quarter was applied. Tests for unit roots and stationarity (Augmented Dickey Fuller, ADF) as well as estimation of cointegration between price series were also carried out.

3. ENVIRONMENTAL POLICIES

The outset of the 1990's was very intense in terms of climate negotiations, with several global meetings taking place. In 1992 the United Nations Framework Convention on Climate Change was adopted. It aimed to prevent adverse anthropogenic emission within a time frame that is necessary for ecosystems to adapt, avoid food systems being threatened and enable sustainable development. Conference of Parties (COP) was set up by the Convention to promote and review the implementation of the Convention and to keep the entire process on track. In December 1997 the Kyoto Protocol, the most momentous agreement so far, was adopted. It set terms for legally binding commitments for industrialized countries. It named six greenhouse gases to be reduced including carbon dioxide, methane, nitrous oxide as well. The Protocol did not include new long-term objectives, it built further on the Climate Convention. The reduction limit industrialized countries agreed on was 5% with respect to 1990 level for the target period 2008-2012.

In the US several federal measures have been taken to control their emissions. In October 2009 The US Environmental Protection Agency finalized the rules for Mandatory Reporting for Greenhouse Gases by 31 industries and emission sources. 2 months later, in December 2009, light-duty vehicles were classified as danger to public health and welfare, which was followed by the publication of Corporate Average Fuel Economy and GHG emission standards for light-duty vehicles of model years 2012-2016. In May 2010 EPA announced its plan to

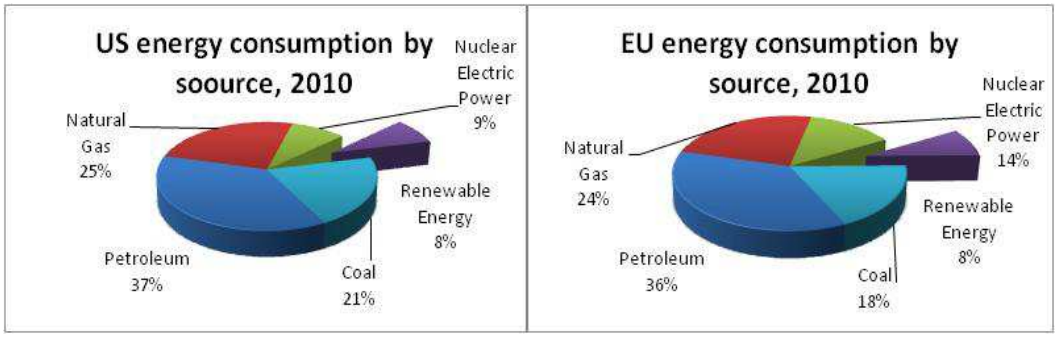
regulate GHG emission from large industrial polluters, such as power generation facilities, industrial boilers and oil refineries (EPA, 2011).

4. WORLD ENERGY DEMAND

In spite of the global economic crisis of 2008 and 2009 world total energy consumption has been growing and this trend is projected to continue. According to the OECD (2010), the total primary energy supply was 12 029 million tones of oil equivalent (Mtoe) in 2007 and is expected to reach 13 488 Mtoe by 2015. The contribution of renewable energy sources to the total energy supply was 12.6% in 2007 and forecast to slightly increase to 13.5% by 2015.

In 2010 the US' energy supply exceeded 97.982 quadrillion Btu (EIA, 2011). As Figure 1 shows the total supply was provided by five sources. Petroleum had the highest share with 37%, natural gas had 25%, coal amounted to 21%, nuclear electric power to 9, while renewable energy made up 8% of the total, which exhibits a slight increase compared to the previous years. This rise is attributed to biofuels and wind, however, there was a decrease in conventional hydroelectric power use. As Figure 1 illustrates the EU has a very similar pattern of energy consumption with respect to source.

Figure 1. US and EU energy consumption by source, 2010



Source: Energy Information Administration

EIA (2009) estimates the contribution of transportation sector to the US total energy demand was 27 percent in 2009. This includes all the energy consumed to move people and goods by road, rail, air, water and pipeline.

The production of bioenergy has increased all around the world. Rajcainova (2011) indicates that the world bioethanol production reached 19.5 billion gallons,

while biodiesel was estimated to be around 3.9 billion gallons in 2009.The underlying reason for its popularity is that it has been considered as a possible energy source that might help to broaden the energy portfolio to battle increasing energy prices, to curb greenhouse gas emissions, to create jobs and offer new income in rural areas.

5. BIOMASS LEGISLATION IN THE US

According to the Biomass Research and Development Board America (BRDB, 2008) owns one-third of the world's automobiles (approximately 230 million) and uses twenty-five percent of the world's oil. Its economy is dependent on liquid transportation fuels, mainly derived from petroleum, to power cars, buses, trucks, locomotives, barges and airplanes. Use of petroleum has raised concerns about energy security, climate change and other environmental issues. BRDB (2008) projects that with no alternatives to petroleum products and the same rate of use reliance on import oil will lift to 30 percent by 2030 and the greenhouse gas emission of transport sector will increase by 40 percent. There is general agreement over the need for viable petroleum alternatives to address the challenges the American society is faced.

Biofuels (bioethanol and biodiesel) are regarded by the Administration as a possible near-term strategy to tackle energy security and climate change. In 2006 President George Bush stated that America "is addicted to oil" and introduced the Advanced Energy Initiative (AEI), which involved increased research funding for cutting edge biofuel production processes. At the beginning of 2007 the "Twenty-in-Ten" initiative, a plan to cut back on gasoline consumption was announced. It aimed a reduction of 20% in 10 years. A stressful point of the plan was a request that Congress mandate to increase domestic renewable and alternative fuels production to 35 billion gallons per year (BGY) by 2017. Renewable Fuel Standard (RFS) as part of the Energy Independence and Security Act (EISA) was passed and enacted.. The RFS requires 36 billion gallon of biofuels by 2022 in every year to be produced, and involves specific provisions for advanced biofuels, such as cellulosic ethanol and biomass based diesel. In the same year the Bush Administration proposed a Farm Bill, including $1.6 billion for new renewable energy and energy efficiency-related spending at the U.S. Department of Agriculture (USDA). $210 million from this amount were to support loan guarantees for cellulosic ethanol projects. The Farm Bill was passed in May 2008, named the Food, Conservation, and Energy Act of 2008, with more than $1billion in compulsory funding for such energy activities. Meanwhile, major steps had been taken by Federal agencies to implement the Advanced Energy Initiative. In

partnership with the private sector and academia the Department of Energy (DOE) announced an investment plan totaling nearly $1 billion for research, development, and deployment of advanced biofuel technologies by 2012. $272 million was earmarked for commercial-scale biorefineries, $240 million for demonstration-scale biorefineries and over $400 million for bioenergy centers (BRDB, 2008).

6. BIODIESEL AND SOYBEAN PRODUCTION OF THE US

The US produced 13321 million gallons ethanol and 311 million gallons biodiesel in 2010 (AFDC, 2011). Between 2006 and 2010 ethanol production increased by more than 50% to exceed 1 quadrillion British thermal unit (Btu). As new measures under the Clean Air Act Section 211 that promotes the production of ethanol are set to be taken, this number is expected to rise further. Biodiesel production has considerably been outweighed by bioethanol production. However, it saw a rapid growth from 2004 with a production of 28 million gallons going up to 678 million gallons in 2008. Latest data related to last year's production indicates a production of 311 million gallons. This sharp drop is ascribed to fall in demand as domestic production decreased due to the expiration of the biodiesel blender tax credit at the end of 2009 and a further decline in imports. The credit was later extended retroactively for 2010 and forward through 2011, so production and consumption could pick up temporarily. Though, there are uncertainties about how the industry reacts to the one-year renewal.

Biodiesel is generally produced from plant oils (such as rapeseed, soybean oil and palm oil), some animal fats (tallow), and recycled waste cooking oil. The main feedstock for biodiesel production in the US is soybean oil. For soybean oil production, there has not been significant fluctuation in its production volume. According to the USDA (2011) in 2001 18 898 millions pounds, in 2005, while for 2010 19 035 is forecast. With biodiesel production having risen significantly over the past 10 years, the nearly constant volume of soybean oil production suggests a change in usage. This change is underpinned by USDA data that exhibit an increase in the share of soybean oil used for biodiesel production from 2006 until the global recession hit the world, but it is forecast to grow again in years to come.

Since biodiesel is, in essence, a substitute for conventional diesel, biodiesel price is driven largely by the price of conventional diesel. As feedstock costs (soybean price) have a great share in total biodiesel production cost (it constitutes approximately 80 percent), it is assumed to have a large impact on biodiesel

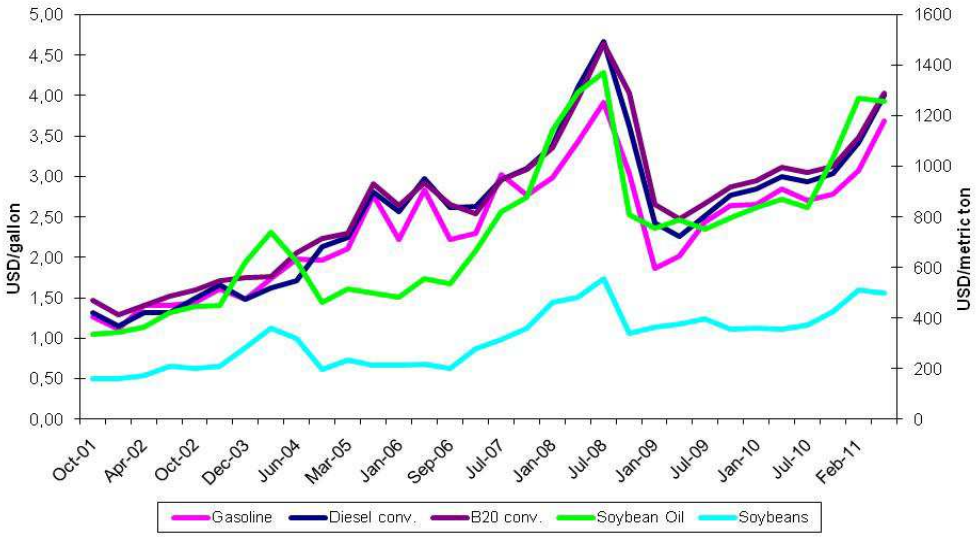
prices, but in general, biodiesel is deemed to drive soybean prices. Consequently, conventional diesel price also can affect feedstock price through biodiesel price.

The volume of biodiesel production is relatively small if considering the entire diesel market, so shifts in the production of biodiesel have very little if any effect on diesel price. Though, the amount of soybean oil used to produce biodiesel is significant with respect to the size of the soybean oil market, reaching 13% in 2008 (U.S. Census Bureau, 2011), and it might drive up soybean oil prices, even to a level where it becomes uneconomic to produce biodiesel from soybean oil.

7. RESULTS AND DISCUSSION

Since early 2001 biodiesel prices in the United States have trended upward (Figure 2). However, there have been fluctuations. The highest price reached $4.64 per gallon in July 2008, while the lowest at the amount of $1.29 was observed in February 2002. Similarly, soybean oil price has also increased in the examined period. It stood at $334 per metric ton in 2001, it spiked to near $1400 in July 2008 and after almost 2 years of depressed prices a rise began again in summer 2010.

Figure 2. Development of US fuel and food prices from 2001-2011



Source: US Department of Energy, US Department of Agriculture

Correlation analysis (Table 1) revealed an extremely strong positive correlation (0.991) between diesel and biodiesel (B20) prices and a bit weaker, but also strong relationship (0.694) between biodiesel and soybean oil prices. All correlations are significant at the 0.01 level (2-tailed).

Table 1. Correlation Matrix

Variable	Gasoline	Diesel	B20	Soybeans	Soybean Oil
Gasoline	1	-	-	-	-
Diesel	0.976	1	-	-	-
B20	0.967	0.991	1	-	-
Soybeans	0.627	0.655	0.654	1	-
Soybean Oil	0.695	0.713	0.694	0.971	1

Source: Own calculation

In contrast, partial correlation analysis (when gasoline was selected as control variable, so its effect on the correlation between biodiesel, soybean and soybean oil was controlled for) gave no statistically significant results.

Table 2.
ADF unit root test

	Level	First Differences
Gasoline	-2.85	-3.72
Diesel	-2.93	-3.79
B20	-3.05	-3.86
Soybeans	-2.57	-5.52
Soyb. Oil	-2.90	-4.41

Source: Own calculation

Results are significant at the 0.01 level. Critical values: -4.29 (1%),
-3.56 (5%), -3.21 (10%)

Table 3.
Unrestricted Cointegration Rank Test (L-max and Trace test)

	L-max test		Trace test	
	r=0	r=1	r=0	r=1
B20 Soyb. Oil	5.10 (0.73)	2.41 (0.12)	7.52 (0.52)	2.41 (0.12)

Pairwise Granger Causality Tests (Lags 2)

Null Hypothesis	Obs.	F-Stat.	Prob.
Soyb. Oil does not Granger Cause B20	30	13.94	8.6E-05
B20 does not Granger Cause Soyb. Oil	30	1.46	0.25

Source: Own calculation

L-max and Trace test statistics: r=0 – no cointegration relationship, r=1 – at most cointegration relationship. Critical values at 5% significance level are 14.26 (r=0) and 3.84 (r=1) for L-max test and 15.49 (r=0) and 3.84 (r=1) for he Trace test. Significance level (p-values) in parenthesis.

We tested for the stationarity of price series by using the augmented Dickey Fuller (ADF) test. In the test the null hypothesis is a unit root for each variable. As shown in Table 2, the test failed to reject the null hypothesis indicating that the levels of all five prices are non-stationary. To achieve stationarity we differentiated the price series. Results now reject the null of a unit root for the five

price series suggesting that fuel prices and agricultural commodity prices are integrated of order one, i.e. they are stationary in first differences.

We examined whether there were cointegrating vectors between biodiesel (B20) and soybean oil prices. We used likelihood ratio and trace test to determine the cointegration rank, r. Results are reported in Table 3. Tests show no cointegration at the 0.05 level. Both the Max-eigenvalue and the trace test statistics of cointegration rank fall under the critical values at 5% significance already at the first instance (r=0).

Table 3 contains the results of Granger Causality test, too. This test is used to determine whether economic variable (time series) is useful to forecast another. Obtained results suggest that change in soybean oil price has an impact on B20 prices changes, but not vice versa.

8. CONCLUSION

The present paper analyzes the statistical relationship between energy, bioenergy and food prices. First, data were collected for gasoline, diesel, biodiesel (B20), soybean and soybean oil, covering nearly than ten years form October, 2001 to May, 2011. In order to find out the direction and the strength of correlations between the examined variables different analysis were conducted. Coefficients of correlation matrix indicated strong positive relationships between all the variables suggesting their prices movements followed each other to a certain extent. Trace and likelihood ratio tests rejected the presence of cointegration relation between biodiesel and soybean oil price series at 5% significance level (possible cause of this might be the limited availability, accordingly, small amount of data). Finally, Pairwise Granger Causality test were carried. The result of this analysis might look a little different from what is generally expected when the direction of correlation between biofuels and their feedstock is searched, but the test detected a Granger causality from soybean oil to biodiesel, but not the other way.

As this paper focused solely on the US market, it is recommended to extend the scope of the research to other regions as well.

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